

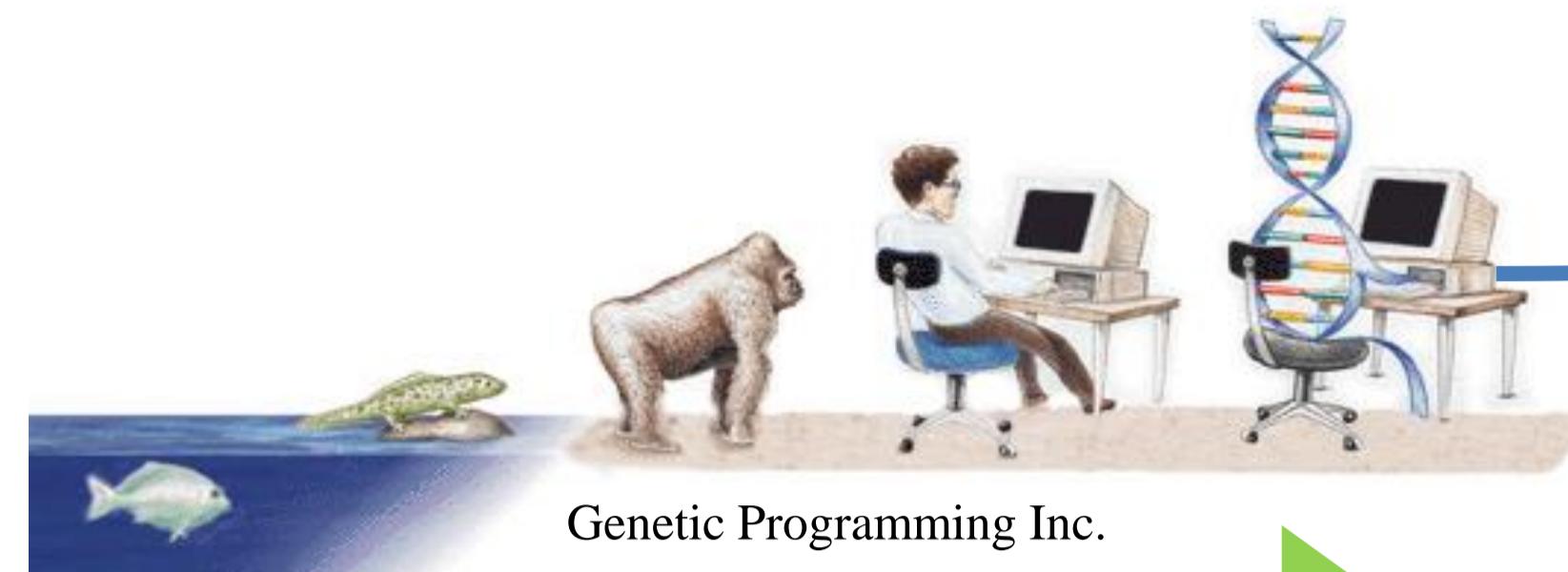
Name	Prof. Hitoshi Iba	Research place	Hongo	Research topic	Evolutionary systems Deep neuro-evolution
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# Emergence of Intelligence

Nature-inspired computation and optimization

$EC + DL + ML \doteq AI + AL$  (Artificial Intelligence + Artificial life)



Genetic Programming Inc.

Deep neuro-evolution



Neuro-Darwinism



DL  
Deep learning

EC  
Evolutionary Computation

GA, GP, DE, PSO, EDA,  
ABC, FA, CS, ....  
Meta-heuristics  
Swarm intelligence

Black-box optimization



Transfer learning,  
Bayesian statistics,  
Belief net,  
MCMC  
.....

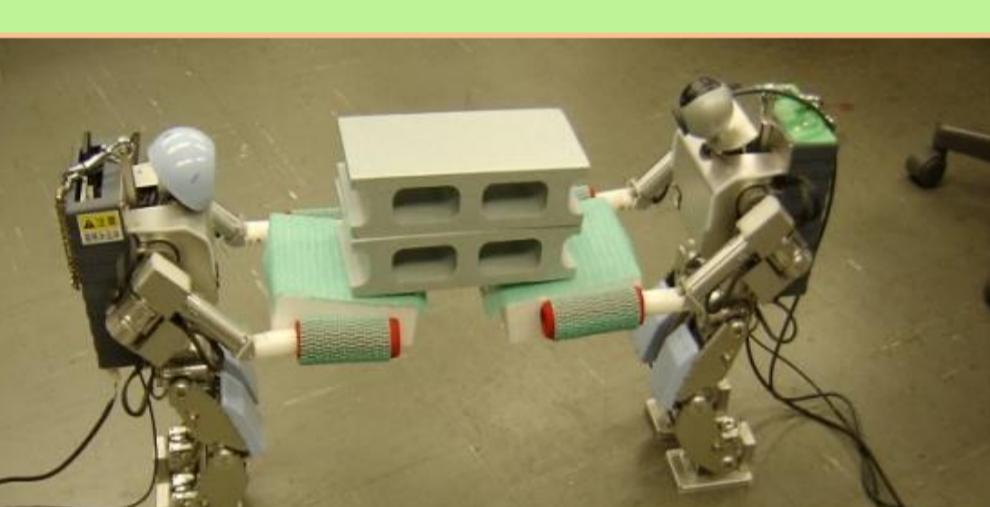
ML  
Machine Learning

In our laboratory, we study computation and systems with the keywords of *evolution* and *emergence*.

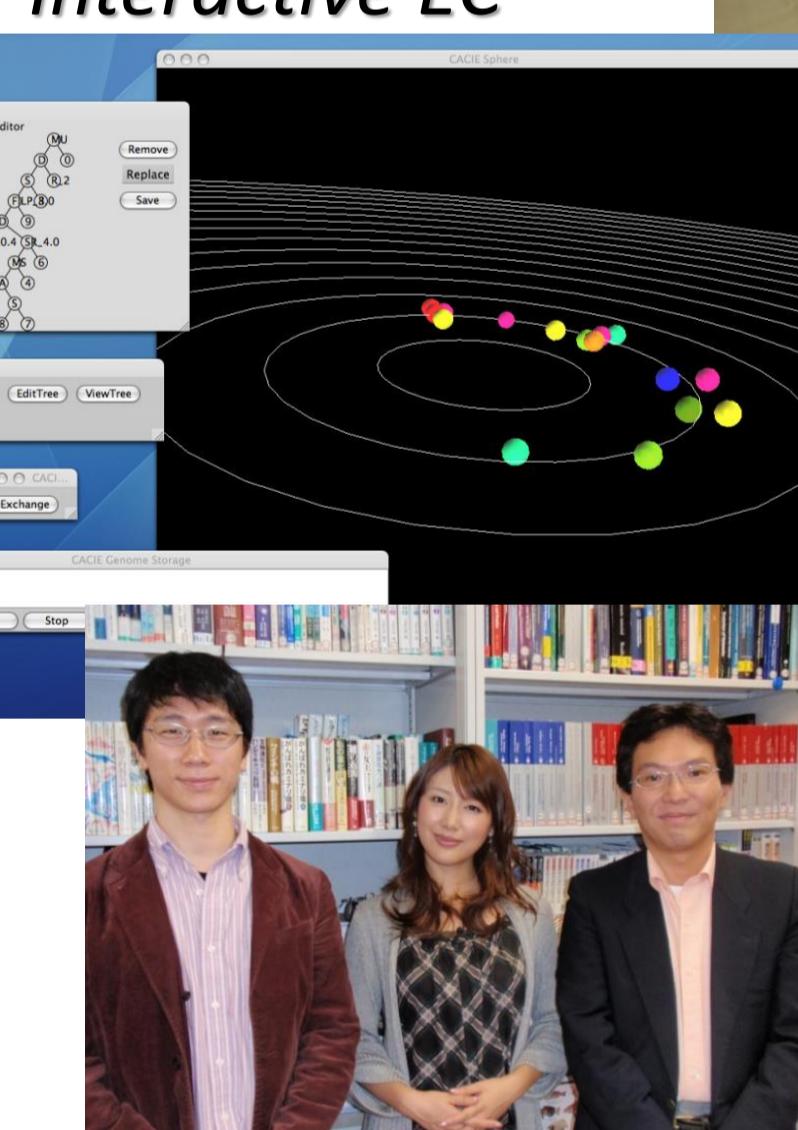
- Why are the peacock's feathers so incredibly beautiful?
- Why did the giraffe's neck become so long?
- If a worker bee cannot have any offspring of its own, why does it work so hard to serve the queen bee?

We see that biological organisms are solving certain types of optimization problems through the process of evolution. It is the objective of the evolutionary method to exploit this concept to establish an effective computing system (*an evolutionary system*).

音色  
ライジングバル  
オープニング  
ターダム  
スネアドーム  
バスドラム  
  
Music composition  
by means of Interactive EC



Evolutionary robotics :  
Cooperative transportation  
by humanoid robots



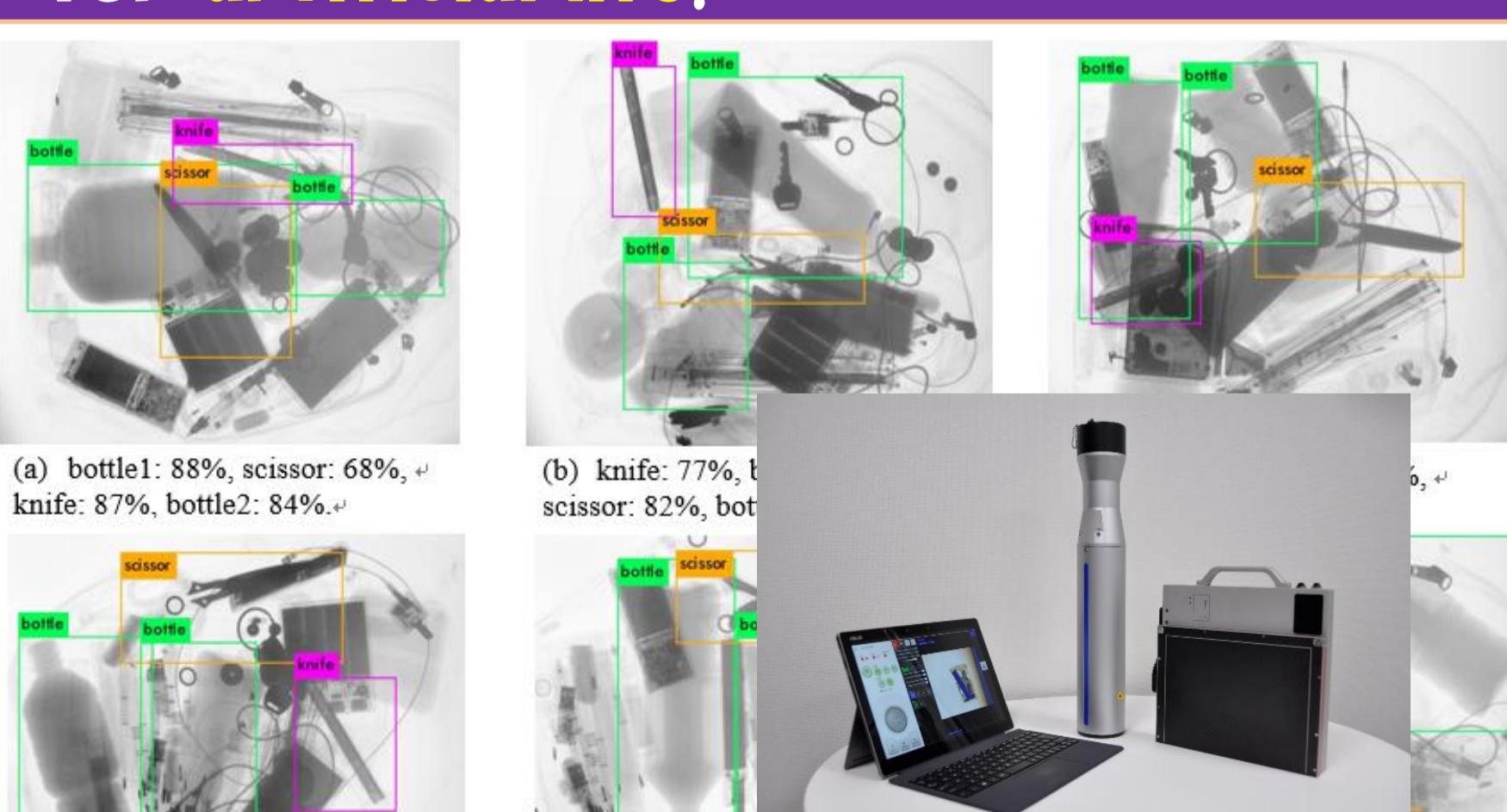
**Neuro-evolution** is a framework that integrates DL and EC. The main feature of neuro-evolution is that it genetically searches for the optimal network and its learning parameters, thereby eliminating the time and effort (e.g., network construction by trial and error) associated with conventional neural network search.

EC is integrated with ML and is widely applied not only in engineering optimization but also in financial engineering, art and design. Evolutionary reinforcement learning has been applied to robotics and game AI.

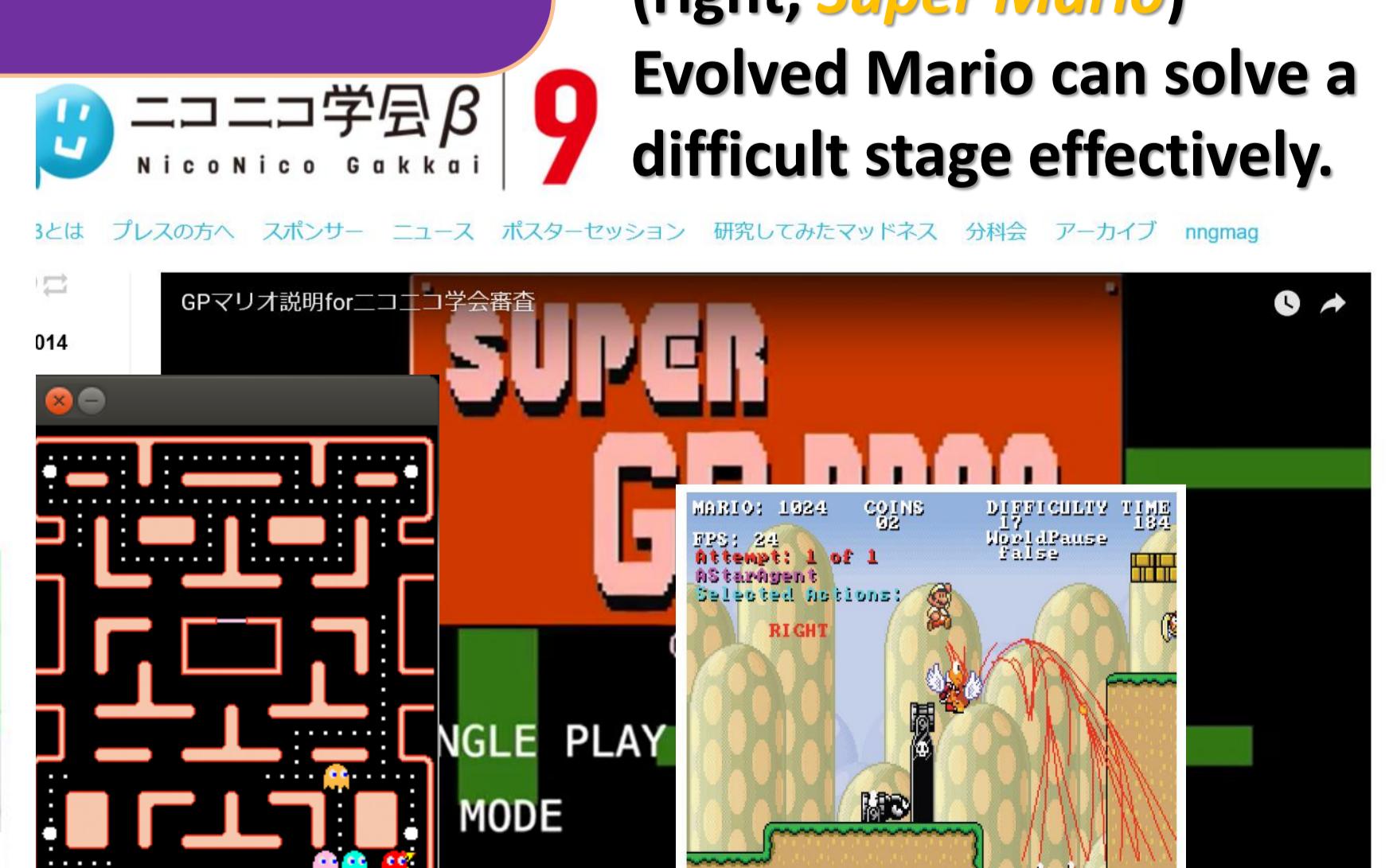


Financial trading system by means of GP

These methods aim to integrate engineering and life sciences, and to realize the main concepts of life phenomena, such as "symbiosis" and "diversity." In addition, it will lead to the elucidation of the phenomena of "emergence" and "complex systems" for artificial life.



X-ray based detection system for dangerous objects by means of deep neuro-evolution



Game AI:

(left, Ms. Packman)  
Evolved luring behaviors by means of GP.

(right, Super Mario)

Evolved Mario can solve a difficult stage effectively.



Evoart  
portrait  
collection



- URL <http://www.iba.t.u-tokyo.ac.jp>
- Email [iba@iba.t.u-tokyo.ac.jp](mailto:iba@iba.t.u-tokyo.ac.jp)